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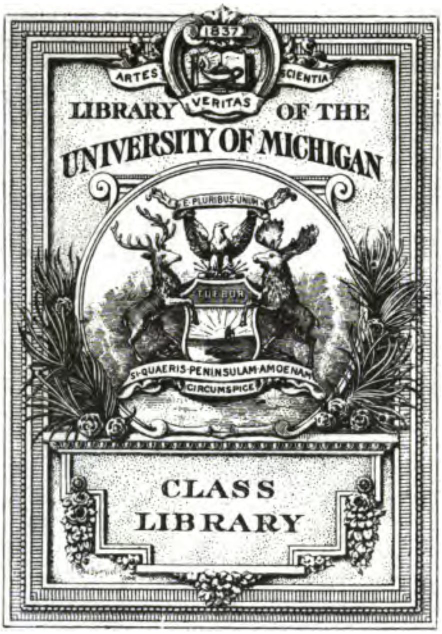
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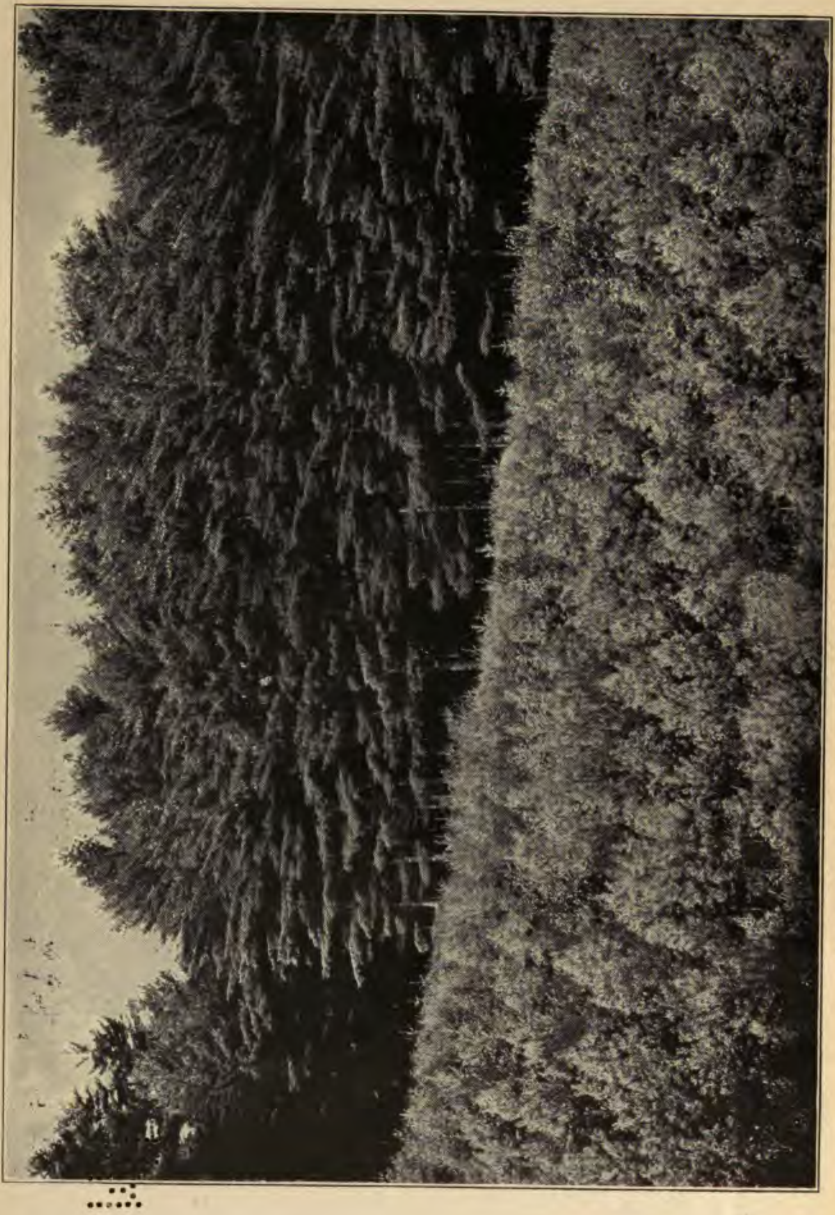

WHITE PINE SEED WOODS AND PERFECT REPLACEMENT ON PASTURE LAND.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF FORESTRY—BULLETIN No. 63.

GIFFORD PINCHOT, Forester.

THE NATURAL REPLACEMENT OF WHITE PINE ON OLD FIELDS IN NEW ENGLAND.

BY

S. N. SPRING, M. F.,
FOREST ASSISTANT, BUREAU OF FORESTRY.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

FORESTRY DEPARTMENT

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Forestry,
Washington, D. C., May 27, 1905.

Sir: I have the honor to transmit herewith a report entitled "The Natural Replacement of White Pine on Old Fields in New England," by S. N. Spring, M. F., Forest Assistant in the Bureau of Forestry, and to recommend its publication as Bulletin No. 63 of the Bureau of Forestry.

The four plates and one map accompanying the text are necessary for its proper illustration.

Very respectfully,

Gifford Pinchot,
Forester.

Hon. James Wilson,
Secretary of Agriculture.

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THE NATURAL REPLACEMENT OF WHITE PINE ON OLD FIELDS IN NEW ENGLAND.

INTRODUCTION

The increasing use and value of second-growth white pine have caused considerable interest to be taken in its rate of growth and reproduction. Many persons in New England who are familiar with past conditions can recall the time when land which to-day has valuable pine upon it was under cultivation or in use as pasture. When such lots are cut, however, trees of little value frequently replace the pine growth, so that white pine in New England is threatened with extermination. To insure its perpetuation practical methods for its renewal must be employed at once.

SCOPE AND PURPOSE OF THE STUDY.

This study has to do mainly with the life history of second-growth white pine on old fields and pastures in New England. The subject is considered from the germination of the seed to that stage of growth when the tree and the stand of which it is a component part have attained sufficient size for consumption by various woodworking industries.

A general examination of the New England States was made in order to ascertain the broad facts concerning white pine replacement. A special investigation was then made in several typical white pine localities, in which all stages of growth were examined. These data furnished the basis for the construction of the accompanying map.

The purpose of the study is to furnish such information about the characteristics of the white pine and the conditions governing its growth as shall be of assistance to persons in New England who are interested in learning how to make young stands already established most profitable, or how to provide for the further extension of this valuable timber.

CONCLUSIONS REACHED BY THE STUDY.

The conclusions reached by the study are as follows:

(1) The extension of white pine on old fields and pastures has been vigorous in the past, as is shown by the numerous merchantable stands of pure second-growth pine found in several localities in New England.

(2) Many fields and pastures covered at present by seedling and sapling stands give evidence that the white pine is still extending

itself. This extension depends principally upon the presence of seed trees.

(3) The merchantable stands are being rapidly removed on account of the large consumption of pine by certain industries. The common method of lumbering these pine lots leaves no seed trees to provide for future stands.

(4) Under the existing methods of lumbering, which are rapidly reducing the stands from which seeding is taking place, the future extension of pine is likely to be limited to occasional small groups, leaving the greater part of the land to be occupied by inferior species.

(5) The replacement of white pine can be assured by leaving seed trees on each lot when it is cut. If this practice becomes general, the number of stands of merchantable pine in New England will be greater fifty years hence than it is to-day, and the quality of their timber will be better.

(6) The future extension of white pine by natural replacement will be of great value, not only to New England as a whole, but to the individual owner as well, who will be making a profitable investment at a very small outlay.

THE WHITE PINE TREE: ITS HISTORY FROM THE SEED TO THE POLE STAGE.

THE SEED FROM ITS FORMATION TO THE TIME OF GERMINATION.

PRODUCTION OF SEED.

In general, seed is produced when a tree has stored up food in excess of what is needed for growth. The food of a tree is prepared in the leaves under the action of sunlight, and is stored away in twigs, branches, and other parts where it is available for growth. The conditions which favor a tree in the production of food are a full supply of sunlight and a fresh, fertile soil. The quantity and quality of seed depend also upon the form and location of the tree, and upon its age. A tree in the open bears more seed than one in the forest, since it has a larger crown and enjoys more light; few trees produce an abundance of seed when they are very young.

HABIT OF SEEDING.

The seed of the white pine is borne in a cone, sometimes called a "bur," which consists of many scales, arranged spirally and overlapping each other on a central stem. On the upper face of each fertile scale two seeds are developed, each being provided with a papery wing about four times as long as the seed. These wings act as sails and aid in dissemination when the seeds escape from the cone. The seed and wing together are about 1 inch in length.

White pine trees require two years in which to develop their seed, and so in the late summer one can often find immature cones about an inch long on twigs of the season's growth, and mature cones from 4 to 6 inches long on the growth of the preceding year. From these one may judge to some extent the quantity of seed that will be produced during the current and ensuing years.

The cones grow upon the under side of the branches and near their ends. On trees standing in the open, cones may develop on any of the branches, though most commonly they are found on the upper half of the crown. White pines in the forest produce cones only on the three or four whorls of branches at the top of the tree.

Whenever external conditions are favorable for seed production a white pine tree in the open bears cones, but the trees in the forest, under the same conditions, may or may not do so. There we may distinguish three classes of trees, according to the amount of sunlight their crowns receive.

(1) Dominant: Those whose crowns are free to the light on all sides.

(2) Intermediate: Those which are partly shaded, but which are still contesting with the dominant trees for growing space.

(3) Suppressed: Those which are being overtopped by the other trees and will die for lack of sunlight on their leaves.

Suppressed trees rarely bear seed, because they receive insufficient light to enable them to grow well and therefore can not store up any extra food for seed production. Intermediate trees often bear seed in small quantities, but most of the crop is borne by the dominant trees, which have a full supply of light.

The age at which white pine trees begin to bear seed varies considerably. The cones of young trees are often sterile, so that their appearance is not always a guide. Trees may bear seed at 20 years of age, but, as a rule, they are not fruitful in very large quantity until they are about 35 years old. In a thrifty pine stand 27 years old, in Bridgton, Cumberland County, Me., there was, during one seed year, an average of six mature cones to the tree.

SEED YEARS.

White pine usually produces some seed each year, but the seasons when large crops of cones occur are from five to seven years apart. The year of abundant seeding is called a seed year. Often an intermediate year brings a moderate crop of seed, and this is sometimes termed a half seed year. Evidence concerning this periodic seeding was obtained from the age, height, and number of seedlings on sample areas. In Cheshire County, N. H., the preponderance of 6-year-old seedlings on areas examined in 1903 showed that the last seed year was in 1897. In the southeastern part of Bristol County, Mass., age counts were made in numerous young stands, and the ages of the seedlings fell naturally into groups of 6, 12, and 18 years. In some seedling stands in this section the ages of the pines varied by two or three years from the age classes mentioned, disclosing the fact that there had been partial crops of seed in intermediate years.

This regular period of seed production does not necessarily occur at the same time over all of New England or over all of one State, but seed years occur more or less locally, sometimes in a valley, a county, or a still larger section. Then, again, there may be general seed years for the whole white pine belt. Observation of the small cones in the fall of 1903 indicated that 1904 would be a good seed year for white pine in portions of southern New Hampshire, and in Plymouth County and northern Worcester County, Mass. This promise was fully realized.

MATURING OF THE SEED AND ITS DISTRIBUTION.

Cones of two seasons' growth are full grown by the middle of August, and the seed is plump and fully developed, but the cone is green and shows no sign of drying and opening. During the last week in August and the first week in September, however, it turns brown and the scales commence to open. Most of the seeds escape early in September, although some cones retain a few seeds until spring. Cones that were gathered during the last week in September contained only a few seeds on the upper and lower scales. The mature cones remain attached to the tree until the following spring.

Wind is the chief agent in the distribution of white pine seed. The seeds are light, and when freed from the cone they are caught by the breeze and whirled along by means of the wings, just as maple seeds are. Under a strong wind a few seeds may be carried as far as half a mile, but most of those from any tree or forest will fall within a few hundred feet of the tree on which they grew.

The seeds lodge in places presenting many different conditions. They may be covered by leaves and forest litter, be washed downhill in the surface flow, or settle into the grass and pigeon moss of a pasture.

LOSS OF SEED.

Tests have revealed the fact that from 10 to 20 per cent of fresh white pine seed will not germinate. This percentage constitutes the first loss in the crop of seed which is produced in a seed year. Seeds which remain in a wet situation are very likely to decay, while those which fall upon very dry places can not germinate and soon lose their vitality. Animals destroy seed also, by using them as food, squirrels being among the chief offenders. Forest fires destroy practically all the seed on the tracts over which they burn. The seed destroyed in all these ways forms a very considerable part of the

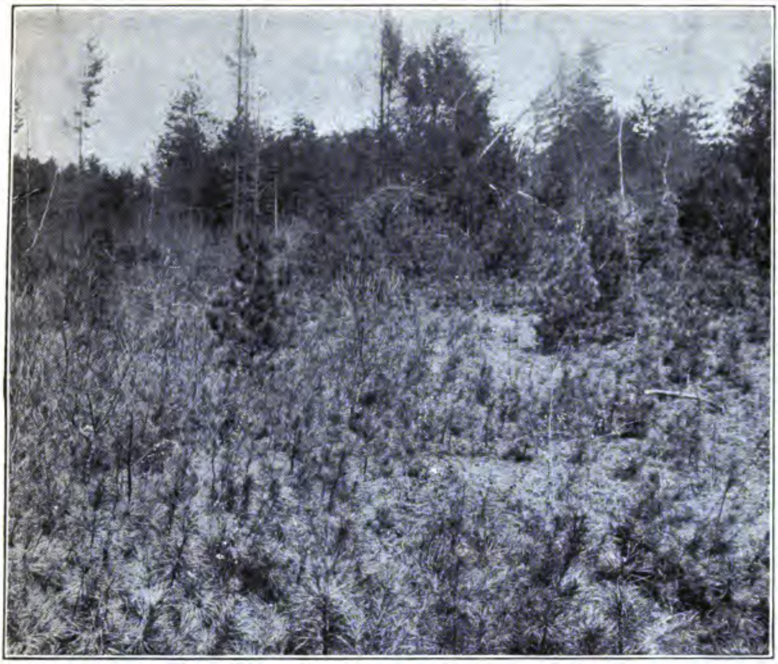

FIG. 1.—GOOD REPRODUCTION OF WHITE PINE ON AN OLD PASTURE.

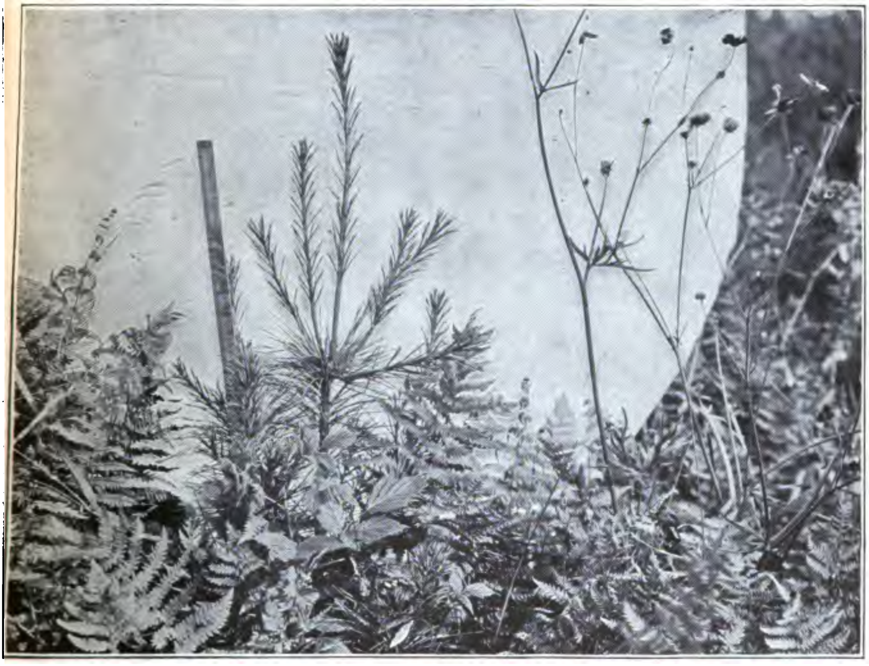

FIG. 2.—HOW A WHITE PINE SEEDLING GROWS IN A FAVORABLE SITUATION.

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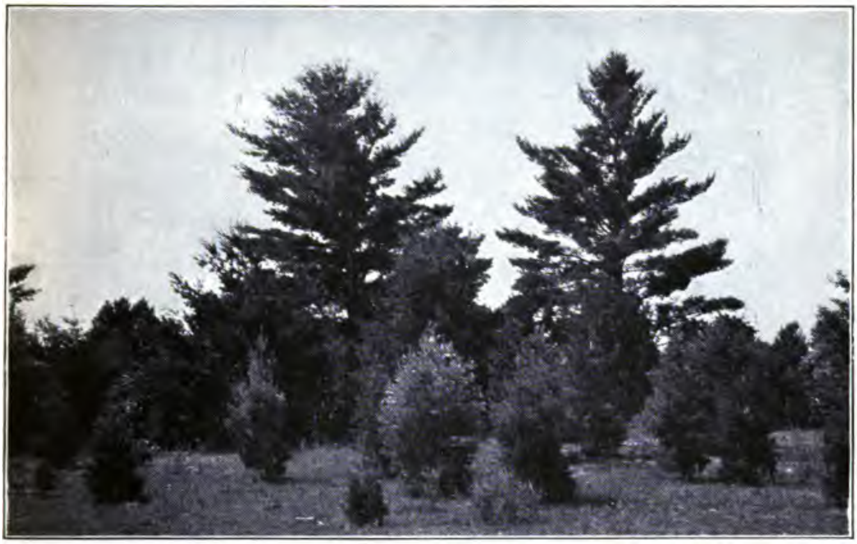

FIG. 1.—POOR, SCATTERED REPRODUCTION OF WHITE PINE ON A CLOSELY GRAZED PASTURE. SEED TREES IN THE BACKGROUND.

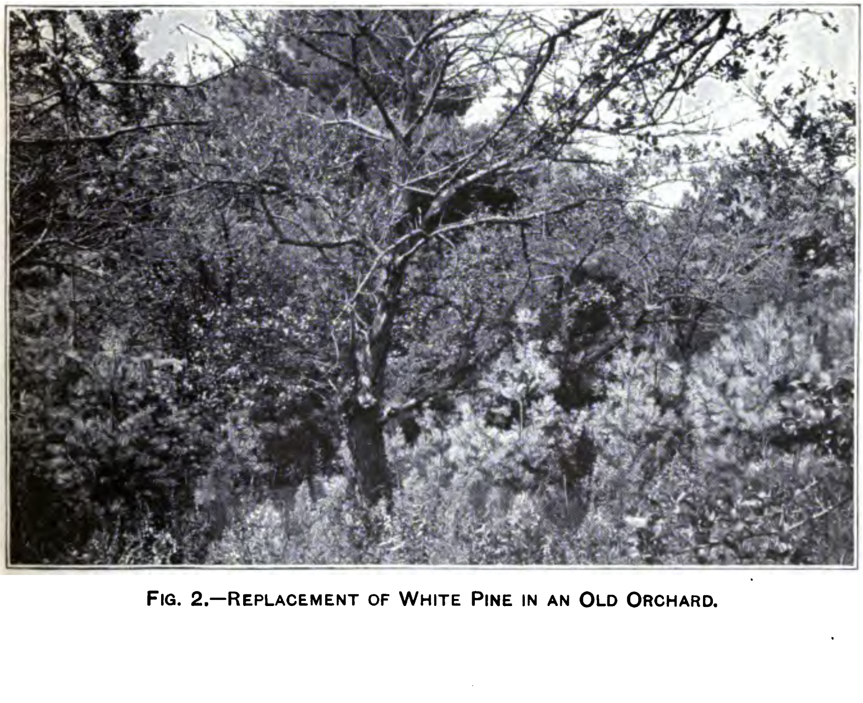

FIG. 2.—REPLACEMENT OF WHITE PINE IN AN OLD ORCHARD.

crop during the best seed years; during light seed years, and especially when drought and forest fires follow the seeding, nearly the whole of the crop may be lost. In spite of these losses, however, a few trees can easily produce enough seed to restock an area reasonably well guarded.

GERMINATION OF SEED.

A certain amount of heat and moisture is essential to the germination of seeds. When the temperature rises to about 45° F. in the spring, all vegetation begins the process involved in yearly growth, and the seeds in the ground begin to take up moisture and to germinate. A moderately even amount of moisture is required in germination. The supply of moisture depends primarily on the regularity and the amount of rainfall during the season, but more especially upon the conditions presented by the individual spot upon which the seed has lodged.

The rainfall in New England furnishes sufficient moisture to insure the extension of the forests by natural reproduction, but its amount and distribution in point of time have considerable variability. A period of six weeks in May and June of 1903 almost entirely without rainfall furnishes an illustration of the irregularity of precipitation. Such a period of drought may cause many seeds to lie dormant until the next year, or to be destroyed. Seeds which lodge in very dry situations, where nothing preserves the moisture in the soil, will not germinate. The vitality of the seeds, their ability to take up moisture and germinate, grows less with age, and only a very small proportion ever germinate after the second spring following their ripening. In the woods the moisture in the soil is retained through the protection afforded by the crowns of the trees and the forest litter on the ground. If this litter is not too deep, conditions favorable to germination and growth are offered, but it may easily happen that so much undecomposed vegetable matter is present that the seeds, though they germinate, are lost because their tiny rootlets can not reach the mineral soil. In the open, favorable conditions of moisture may result from the cover of grass, weeds, moss, or ferns on the ground. (Pl. II, fig. 2.)

THE SEEDLING STAGE.

APPEARANCE AND DEVELOPMENT OF THE SEEDLING.

In forest description a seedling is understood to mean a tree grown from seed which has not reached a height of 3 feet.

During the first three years of its life a white pine seedling is so inconspicuous that the average observer is almost sure to overlook it. For two years it is a simple, straight stem, bearing a little tuft of needles. These needles grow in bunches of five, each bunch surrounded at the base by a little sheath. The first branches are usually developed at the beginning of the third year, but frequently they do not appear until the fourth year.

During this early stage seedlings in the open are almost hidden in the grass and weeds (Pl. III, fig. 2); on the brown needle litter of the pine woods they are more noticeable. In the meadows the mower passes over them without injuring them. In the next two seasons, when more rapid growth commences, the leading shoots of the seedlings appear everywhere in the grass, and the impression is given that they have sprung up in a single year.

The growth in height of natural seedlings for the first ten years is shown in Table I. Plants grown in a nursery, or under especially favorable circumstances, may be much larger.

TABLE I.—*Height growth of white pine seedlings.*

[From measurements of 1,600 young trees.]

Age.	Height.	Age.	Height.
Years.	*Inches.*	*Years.*	*Inches.*
1	1.0	6	17.0
2	1.5	7	24.0
3	3.5	8	32.0
4	7.0	9	45.0
5	11.0	10	64.0

The growth of the roots of a pine seedling corresponds somewhat closely at first with the slow development of the stem, the roots entering the ground only to a very slight depth during the first two years. The white pine has no taproot, but develops three or four stout roots, which grow downward in a slanting direction and gradually give the tree a firm hold on the soil, so that there is but little danger of the grown tree being overthrown by wind. This root system is intermediate between one that is shallow, such as that of the spruce, and a deep root system like that of the oak.

FACTORS WHICH INFLUENCE THE EARLY DEVELOPMENT OF SEEDLINGS.

A white pine seedling is subject to many dangers during the first two years of its life. Fire, frost, drought, and deficiency of light, as well as many living enemies, are apt to threaten it.

Fire is the arch enemy of all forests. It completely destroys pine seedlings, but as extensive fires are not common on the old fields and pastures which are reproducing pine, the loss from this cause is rarely great. It is important, however, rigidly to exclude fire from every stand of young pine.

Frost is to be feared when an untimely drop in temperature catches the tender plant after its growth has begun in the spring or before its new wood has become hardened in the fall. Fortunately, serious damage from this cause is not common in New England.

Moisture is a prime necessity, and if the soil becomes dried out to the slight depth to which the roots have penetrated a great many seedlings die. Wherever the right condition of moisture is maintained the growing seedlings have a good chance for development. They are characteristically found on the edges of clumps of ferns, spiræa, or golden-rod, in bunches of grass, or among low-bush blueberries and blackberry vines. (Pl. II, fig. 2.)

The available moisture at or near the surface is controlled by the physical properties of the soil, the character of the situation, and the composition of the ground cover. The soils of the white pine region of New England are porous and well drained, varying in nature from sand to sandy or gravelly loam. A loose, shallow soil does not retain its moisture well, and if the situation is a south or west slope of moderate steepness, evaporation is very rapid. The ground cover tends to retard evaporation by furnishing shade and hindering the circulation of the air, and it is therefore on the poorest situations that the ground cover is most important. In general, a good soil and a cool or moist situation bear a thick plant growth, while a poor soil or dry situation will support only a sparse vegetation. The thick, tall grass on rich, moist meadow lands illustrates one condition, while the loose growth of bunchy grass on a stretch of pure sand exemplifies the other.

Grass, pigeon moss, ferns, meadowsweet, golden-rod, blueberry bushes, and trailing blackberry vines commonly make up the ground cover.

LIGHT REQUIREMENT.

Sunlight is not essential to seed germination, yet it is required as soon as the first needlelike leaves appear on the young stem of the seedling. Seeds often germinate in places where little light enters, but eventually they will die for lack of it. Pines which come up under pine woods in fairly dense shade often live for several years, though spindling and stunted. In open, young stands, white pine seedlings are more vigorous and may, under favorable conditions, live to form a component part of the mature stand. Pines which start in the open field or pasture have a sturdy growth, are often bushy in appearance, and are quite different from the slender seedlings found in the woods. This character of development shows the light requirements of the white pine.

The demand for sunlight, together with the winged character of its seed, is the cause of the white pine's extension over old fields and pastures and its absence from fairly dense woods. In a scale of tolerance—that is, the ability to endure shade—it occupies an intermediate position between trees like the hemlock, which can grow in fairly deep shade, and those like the gray birch, which requires full sunlight from the beginning of its life.

LIVING ENEMIES.

In the seedling stage white pines are subject to injury from several causes, among which are grazing animals and insect pests. Injury from cattle is noticeable only in overgrazed pastures (Pl. III, fig. 1), as cattle avoid the pine seedlings when they can find anything else to eat. The chief injury on overgrazed land results from trampling, which deforms the seedlings seriously at a time when straight, perfect growth is very desirable.

Insects often injure the foliage, stems, and roots of pine seedlings when other food is wanting, and also do serious damage at later stages in the life of the trees.

SAPLING AND POLE STAGES OF WHITE PINE.

GROWTH.

Most of the stands of second-growth white pine on which this study is based fall within the seedling, sapling, or pole stages of growth. These terms are used to designate periods in the life history of a tree,[a] and for convenience their limits have been arbitrarily fixed as follows: Trees from 3 to 10 feet in height are small saplings; those over 10 feet high and less than 4 inches in diameter are saplings; those from 4 to 8 inches in diameter are small poles; and those from 8 to 12 inches in diameter are large poles. This scale assumes that the trees are normally developed, and makes the point of diameter measurement breasthigh, or about 4½ feet from the ground.

During all these stages the white pine grows rapidly, straight and tapering, with few or many branches according to whether it is crowded or not. Its annual growth in height is characteristically defined by the whorls of branches that are produced each season at the base of the new terminal shoot. Isolated saplings in a pasture are bushy in appearance, and usually retain this character throughout life. (Pl. III, fig. 1.) Their stems are relatively short, and taper rapidly toward the top. Height growth is slower but diameter growth more rapid than with trees in the forest.

The form and development of the individual pine in the forest varies with the fertility and depth of the soil, the density and component species of the stand, and the position of the tree with respect to light, that is, whether it is dominant, intermediate, or suppressed. In general, the pine in the forest is characterized by a smaller crown and a longer, more slender stem than trees in the open.

After the seedling stage is passed, second-growth white pine grows rapidly for fifty or sixty years. This is clearly shown in Tables II and III, which were made up from measurements of 1,600 standing and 500 felled trees of various ages. In Table II it will be seen that the maximum rate of height growth occurs when the tree is from 30 to 40 years of age, after which it gradually decreases. The period of fastest height growth shows the struggle of the individual trees for space and light after the stand has begun to close up by the interlocking of the branches.

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[a] Primer of Forestry, by Gifford Pinchot. Bulletin No. 24, Part I, Forest Service.

TABLE II.—*Rate of growth in height of white pine.*

Age.	Height.	Average annual growth for each 10 years.
Years.	*Feet.*	*Feet.*
10	5	0.5
20	14	.9
30	32	1.8
40	54	2.2
50	68	1.3
60	76	.9

Average annual growth in 60 years............. 1.3 feet.

The rate of growth in diameter (Table III) was determined by measuring the width of the annual rings by decades on the stumps of dominant trees. The rings widen from the center outward for several years, and then begin to be narrow again. Thus the rate of growth in diameter is fastest during the second ten years; but it must be kept in mind that the amount of wood grown each year during this period is not large, since the area of the rings is small compared with those grown later. The rate of growth in diameter decreases as the tree grows older, and it may take a 60-year-old tree three times as long to grow 1 inch in diameter as it does one 10 years of age.

TABLE III.—*Rate of growth in diameter of dominant white pine.*

Age.	Diameter inside the bark, 1 foot high.	Average annual growth for each 10 years.	Average time required to grow 1 inch.
Years.	*Inches.*	*Inches.*	*Years.*
10	1.3	0.13	8
20	5.8	.45	2
30	9.3	.35	3
40	11.8	.25	4
50	13.8	.20	5
60	15.8	.20	5
70	17.4	.16	6

Table IV gives the contents in cords in white pine trees of different diameters, computed from the measurements referred to above.

TABLE IV.—*Volume of single white pine trees.*

Diameter, breast-high.	Volume, excluding bark.	Diameter, breast-high.	Volume, excluding bark.
Inches.	*Cord.*	*Inches.*	*Cord.*
4	0.025	11	0.215
5	.030	12	.260
6	.045	13	.305
7	.065	14	.355
8	.090	15	.415
9	.120	16	.490
10	.165		

DAMAGING AGENCIES.

During the life of a second-growth pine stand more or less damage is done by fire, insects, snow, ice, severe wind storms, etc. As a rule the white pine suffers little from wind, on account of its strong root system, but under the weight of a heavy load of ice or wet snow its top and branches may be broken. Fire, which in general is the most serious of all enemies of young forests, is not, as has already been pointed out, a serious danger under the conditions here described.

During the sapling stages the white pine weevil is the most serious enemy of the white pine. The appearance of the injured trees is characteristic, for the new shoot of the season withers and dies after having grown only a few inches. The pines attacked are usually from 10 to 20 years old. Isolated pines in a pasture or by a roadside are often attacked three or four times, when they become permanently deformed; but trees in a forest stand are usually less damaged. In either case, those which are injured continue their height growth by the substitution of a side branch, which turns upward to take the place of the leading shoot. In this way a crook results which may cause waste when the timber is utilized. The seriousness of the attacks of this insect vary considerably in different localities.

Dr. A. D. Hopkins, in charge of forest insect investigations, Bureau of Entomology, is authority for the following statements regarding this insect:

The white pine weevil (*Pissodes strobi*) is a reddish-brown snout beetle, mottled with white and yellow markings, and varies in length from $\frac{3}{8}$ to $\frac{5}{8}$ of an inch. The adults of the over-wintered broods appear on the wing in April and May, earlier toward the South, and later in the far North and at high altitudes.

The species, as at present recognized, infest the bark on stumps and logs of felled trees and also the trunks of injured and dying ones of all the eastern species of pine. It is especially destructive to the terminal or leading shoots of healthy and vigorous white pine saplings, but it rarely attacks the terminals of other conifers. The principal facts in its habits and life history, as related to white pine reproduction, may be briefly stated as follows: In the latitude of Pennsylvania, below an altitude of 1,000 feet, the beetles deposit their eggs during May in the bark of the leader of the previous year's growth, from the time the tree is five or six until it is about twenty-five years old. More than one hundred eggs may be placed in a single terminal, but usually there are less. The eggs soon hatch into minute white grubs, which remain beneath the bark feeding upon the soft inner tissue. They grow so rapidly that by the last of June most of them attain full size, cease feeding, and prepare cocoons, in the outer wood or in the pith, from coarse excelsior-like borings. They transform in these cocoons to the pupa and adult stages, and emerge during July and August. They rarely, if ever, pass the winter in the terminals, as was heretofore supposed, but the second generation hibernates in the bark of logs and stumps of felled trees.

One of the methods of combating this pest consists of cutting out and burning the infested terminals, but, to be effective, this work must be done during the latter part of June and first of July, before any adults have had time to emerge. The early and late generations in logs, stumps, and dying trees may also be destroyed at the proper time by removing the bark or burning the infested parts.

QUALITY AND USES OF THE WOOD.

The wood of second-growth white pine is soft, straight-grained, and readily worked, but, being largely sapwood, is not durable. It is less dense and weaker than virgin growth, and contains numerous knots, produced at the bases of branches, which the young trees have not had time to shed and cover over. The lumber is usually of a low grade, but it is always in demand at good prices for match blocks, pail staves, and box boards. Trees of a diameter as small as four inches can be used for these purposes. Thus a market is provided in some localities for the trees removed, when a thinning of the stand is necessary, at 30 years of age.

After the pine reaches the manufactory there is little waste. The largest portion possible is utilized for making the various products mentioned. The sawdust and slabs are used for fuel in running the mill. The edgings are bundled for sale as kindling, and the waste blocks are utilized locally for fuel. In some localities the shavings are baled and sold for stable bedding. It is evident that second-growth pine is as economically and thoroughly used as any tree in New England.

DESCRIPTION OF MAP.

The replacement of white pine upon old fields and pastures under the conditions described is shown by the colored areas on the accompanying map. This map is not designed to show the merchantable pine lots in New England, but indicates where forests of various types are found. The dark-green area shows the region where the pine is extending itself well, owing to the presence of older growth which furnishes abundant seed.

In the area designated by an intermediate shade there are only occasional old stands left, and the replacement of white pine is not so good. The fields and pastures in this region that now have seedling growth upon them were seeded by stands that have since been removed or by occasional seed trees that were not cut at the time of lumbering.

The area represented by the lightest green shows the poorest conditions of replacement, and embraces much the larger part of the whole. Where this land is not entirely waste, other growth has largely occupied the ground. Second-growth pine trees and some small scattered seedling areas are found in these regions, but white pine replacement such as is now found in other sections is impossible because sufficient seed trees are lacking. On this land white pine can be raised in a commercial way only by planting.

In the portions of New England outside the colored area second-growth pine is either wanting or growing under conditions essentially different from the typical and prevalent type which has been described. In Maine there is considerable second-growth pine in the region between the colored area and the boundary of the spruce country to the north and east. It occurs, however, in mixture with the more northern species, reproduces itself poorly, and has a much slower rate of growth. In eastern Massachusetts the uncolored area represents country long ago cleared of its forest and now occupied thickly by populous towns.

THE DEVELOPMENT OF WHITE PINE WOODS ON OLD FIELDS AND PASTURES.

FACTORS CONTROLLING THE ESTABLISHMENT OF THE STAND.

It has been shown that if white pines are to reproduce themselves there must be seed trees to furnish seed, and a suitable condition of soil to insure the germination of the seed. A low growth of grass or weeds is also desirable to protect the tender seedlings against excessive heat; but if this becomes too rank or dense it may do more harm than good, by smothering the young plants or by cutting off the needful light.

Of first importance is the presence of seed trees, without which no pasture, field, or cut-over area can be stocked, except by planting. Observation shows that reproduction is most abundant and perfect where numerous stands of fruitful timber still grow, and that on abandoned fields and pastures which adjoin pine woodlots good

42°
41°30
41°
39°30

seedling or sapling stands are almost always found. (See frontispiece.) On land distant from seed woods the number of pines to the acre is appreciably less, often forming merely an open stand of branchy trees. The average distance to which pine woods of the proper age will completely stock the ground with their seed is about 130 feet. Individual instances of a much wider distribution of seed are common, since the fruitfulness and height of the seed trees and the strength of the wind are important factors, but as a rule 130 feet is as far as the seed are apt to be carried in considerable quantity. For some distance beyond the point where the ground ceases to be fully stocked many scattered seedlings will be found, but they are not close enough together to form an even stand of the same character as the parent woods.

The seed from isolated trees is distributed just as far as that from pine woodlots, but the adjacent area is not completely stocked to the same distance, because a smaller amount of seed is available. Three or four good seed trees, however, may serve to stock an acre and form a close stand.

The prevailing wind during the time when the cones are opening largely controls the direction in which the seeds are distributed. During late August and September the winds are from the southwest, west, or northwest, according to the part of New England under consideration. This fact should be taken into account when trees are selected to be left for seeding purposes.

In the development of seedling stands, the effect of ground cover in controlling both the number of seedlings and their relative distribution over the area is exceedingly important. Two extreme conditions of the surface vegetation occur in which reproduction is scanty or wholly lacking, namely, wherever there is merely a slight, much-interrupted, herbaceous growth on the ground, and where a rank, dense growth of grass, weeds, and brush exists. The first condition usually prevents the germination of seed through lack of moisture, or, if the seeds germinate, the young seedlings die during the first year for want of sufficient shelter to prevent the drying out of the surface soil about their roots. The dense ground cover of the second condition often prevents germination by keeping the winged seed off the ground until it loses its vitality, or it may prevent an adequate supply of light and air from reaching the seedling after germination, and thereby cause it to die.

A third unfavorable condition is found on closely grazed pastures. On poor, sandy soil, where at best only a thin, bunchy grass grows, the chances of pine reproduction are destroyed if the slight ground cover is kept closely cropped by cattle. Even with an abundant supply of seed, such an area will produce only a few widely separated seedlings. On better and more loamy soils excessive grazing tends to pack the earth hard and to develop a thick sod, which prevents reproduction. In a few situations moderate grazing of cattle may be beneficial by preventing the ground cover from getting too tall and dense.

As a rule, however, grazing on land devoted to white pine reproduction must be prohibited or very strictly limited until the seedling stand is well established and the young trees so developed that they will not be destroyed by the cattle.

On the whole, the conditions of the ground cover of New England fields and pastures are in the majority of cases favorable to the extension of pine.

CHARACTERISTICS OF SEEDLING STANDS.

ON CUT-OVER AREAS.

Pine lots after being lumbered are very frequently burned over and used for pasture, because the soil is not valuable for agricultural purposes. No thought is given to the replacement of the white pine. The burning over of the lumbered area favors a thick growth of gray birch, because the light seeds of this tree are at once blown over the lot, where they readily germinate and grow on the bare soil. The fire destroys the organic matter in the surface soil, the pine seedlings which have established themselves, and also the pine seed on the ground awaiting an opportunity to germinate. After the fire the soil and ground cover are less favorable to the growth of pine seedlings. If seed trees are left near such a tract, after some years the pine begins to come in under the birch, since the latter, when not too thick, affords a desirable shelter for the pine. In early youth gray birch grows faster than pine, but that relation is reversed after a few years, and a good many pine seedlings will struggle up through the birches and eventually form another pine stand, of greater or less density and value according to the number of seedlings that survived in the struggle with the birches. There are large areas in New England, once covered with pine, but now occupied by gray birch and other inferior trees because there were no pine trees left to furnish seed. The frequent replacement of pine by hardwoods is largely accounted for in this way.

Land which is not burned over after being lumbered furnishes a better opportunity for the replacement of pine by the same species. The branches and tops which are left rot down in a few years and leave the ground in good condition to support reproduction. Under favorable conditions a good stand of pine results at once, but if a seed year does not occur until five or six years after the lumbering, the pine has to contend with the growth of birches and other species which will have sprung up in advance. This stand of birch, however, is likely to be less dense than a stand on the burned land, and the rapid height growth of the pine after its fifth year usually gives it a good chance to push up through the light foliage of the other species and to establish itself as the predominant tree.

ON ABANDONED LANDS.

Many abandoned farms in the white pine region, notably those in southern New Hampshire, have reverted to pine forest. Cultivated land, when it is abandoned, is soon covered by blackberry vines, grass, and weeds, which, on a loose, well-worked soil form a ground cover of uniform character. Whether a stand of pines will then occupy it depends upon the presence of seed trees. Meadow land, except that situated on rich river bottoms, also offers favorable conditions for the extension of pine, and regular, well-stocked stands often result from one good seed year. Land kept in pasture for many years and closely grazed does not afford so favorable a seed bed when it is abandoned, because of its compact soil and the character of its ground cover. When reproduction of pine takes place the seedlings are likely to occur in groups, on favorable spots unevenly distributed over the pasture. The blanks may be filled by the seeding of subsequent years, but in some cases they resist invasion for a long time.

The number of seedlings per acre varies greatly in different situations. The factors which control the number have already been discussed, but in order to determine how many young trees occupied an acre where seed trees were present and where soil and other conditions were favorable, a number of counts in stands from 2 to 8 years old were made. In many instances these sample areas bore a less perfect stand than they might have had if the reproduction had been looked after, yet it was found that on areas which might be expected to yield merchantable pine lumber thirty-five years hence the average number of trees of all species was 2,113. Of these, 80 per cent were white pine and 20 per cent birch and other less valuable species. Most of the stands were practically even aged, although usually the fruit of more than one seed year was represented. Of course these stands were selected, and the figures obtained from them can not be applied to all areas under natural reproduction. They must be regarded as indicative of what may be, rather than of what is, throughout a large part of New England.

UNDER WOODS.

Another phase of pine reproduction is that of seedling stands in rather open woods. (See Pl. II, fig. 2.) Moisture conditions as well as shelter are favorable to reproduction, but the seedlings grow much more slowly than those in open pasture. One condition which is quite common is the reproduction of white pine under pitch pine on very loose, sandy soil. The pitch pines are usually well separated, the canopy thin, and the ground in good condition for seed germination. Under these trees a perfect thicket of white pines frequently exists.

Stands of hardwoods sometimes offer a favorable opportunity for pine growth, but they are usually too dense to allow many of the pines to survive.

Seedling white pines under older trees of the same species do not thrive unless the stand is a very open one, a condition not often found.

THE CARE OF SEEDLING AREAS.

After the natural reproduction of white pine on a field or pasture has been secured, practically no care is required during the seedling stage, except to prohibit or strictly limit grazing (see p. 18) and to exclude fire.

ASSISTANCE TO NATURAL REPLACEMENT.

Natural replacement of pine can be assisted at a small expense by transplanting seedlings. Such an operation is advisable where the replacement has occurred in groups separated by blank places of considerable size. The transplanting consists in moving some of the seedlings from the groups into the open places. The plants should be not more than 3 or 4 years old, or from 6 to 8 inches high. Holes should first be dug, then thrifty young trees should be lifted out with a spade and firmly set in their new positions. The trees should be placed approximately 5 feet apart in each direction, and the earth packed closely about the roots. In this way a uniform stand of seedlings is promptly secured. In a hard-trampled, close-cropped pasture natural replacement may be aided by plowing strips 6 feet apart and three or four furrows wide just before the seeds begin to fly.

ARTIFICIAL REPLACEMENT.

It is advisable to plant white pine in the pine region of New England where natural replacement can not be secured for lack of seed trees.

The artificial establishment of pine stands has been successfully carried out in several parts of the region.[a] Large areas of nonagricultural land which to-day bear an inferior growth of trees can, by means of planting, be made to yield a net yearly return of 5 or 6 per cent. If taxes and the rent of the land are not considered, the profit may be considerably greater.

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[a] See Bulletin No. 45, Bureau of Forestry. The Planting of White Pine in New England, by H. B. Kempton.

SILVICAL TYPES.

In many situations in New England where older stands of second growth now occupy former clearings, the forest is not all pine, but a mixture of pine with other species. There are few localities in which pine is not preferred, and when it is a question of replacement the most valuable tree should be favored. When the stand is already developed, however, its treatment will be governed by its character and composition. For present purposes it is sufficient to distinguish pure pine stands and mixed stands.

MIXED STANDS.

In most situations the original forest was undoubtedly a mixture of hardwoods and pine, in which the former composed the greater part of the stand upon the better soil of the low hills that characterize the topography of the region. On the lower elevations and poorer soils, especially on the sandy plains, pine formed the greater part of the forest.

In situations where the hardwood growth was predominant, the pine occurred singly or in groups throughout the forest. These pines had a better development than those on the plains, owing to the better soil and their struggle with the hardwoods.

This type of mixed stand exists now in the second-growth forest. The number of pines varies from a few scattering specimens or groups to 50 per cent of the stand.

The character of the original forest was altered by lumbering and by the clearing of the land for farms. Wherever the pine alone was cut, the remaining hardwoods secured full possession of the soil, owing to the inability of pine to reproduce itself in dense shade. Sprout hardwoods replaced the original hardwoods when they in turn were lumbered.

PURE STANDS.

The pure stand is the important one from the commercial viewpoint, since the majority of second-growth pine lots in New England belong to it. Henceforth this report will deal entirely with this type.

The term "pure forest" is commonly extended to include any stand in which at least 80 per cent of the trees are of one species. Most of the second-growth pine in New England is composed of such stands, which have arisen almost entirely by the establishment of white pine on farm land. In many instances the land originally bore hardwoods, but after its moderate fertility was exhausted by agriculture it became better suited to the growth of pine than to more exacting species.

At the time when many people began to go West, about fifty years ago, a great number of these farms were abandoned. The conditions were then wholly favorable to the extension of white pine. Plenty of seed trees were adjacent, and whenever the lands fell into disuse a pure growth of pine generally took possession. The history of any individual tract obtained from local witnesses leads almost inevitably to the statement that the land was formerly farmed and abandoned. Evidence from the character of the land and the presence of deserted farm buildings furnish final proof of this fact. Other stands of this type originated through the abandonment of one portion of a farm, or the steady encroachment of the pine on pastures and hay land. It was frequently necessary for farmers to cut down pine saplings and dig up seedlings in order to retain the use of certain portions of the farm for agricultural purposes. This form of replacement is in progress to-day. (Pl. IV, fig. 1.)

COMPOSITION OF PURE STANDS.

The subjoined tables are derived from measurements made in a number of stands in which white pine composes over 80 per cent of the stand. The species in mixture are largely birch and maple, with occasional cherries, aspens, and oaks. In certain cases (Table VI) other species enter the type—such as spruce, fir, hemlock, red pine, etc.—but these make no essential difference in the character of the forest.

In the seedling stands measured, the gray birch and other species formed about 20 per cent of the average stand. In some cases of incomplete pine replacement the birch forms a much larger percentage of the stand, but since the pine grows more rapidly after the first ten years it usually gains a dominant position by the time the sapling stage is reached. The struggle for space and light determines the final composition of the stand. The gray birch requires an abundance of light, and is either forced up into long, slender poles or killed by the crowding of the pines. The percentage of the birch becomes less and less as the stand grows older, and though the birch may have several years' start and may retard the development of the pine, the latter will finally gain the lead.

If species which are capable of enduring shade, such as red maple, spruce, or hemlock, enter into association with white pine, they may be able to maintain their position as long as the stand exists.

The following tables represent the average of the varied conditions and soils in the white pine district of southern New Hampshire and southwestern Maine. They are based on sample areas of an acre or less in extent scattered throughout this region. The age of each stand measured was determined by careful counts of the branch whorls and scars, and by ring counts on logged trees, checked by information furnished by the owner.

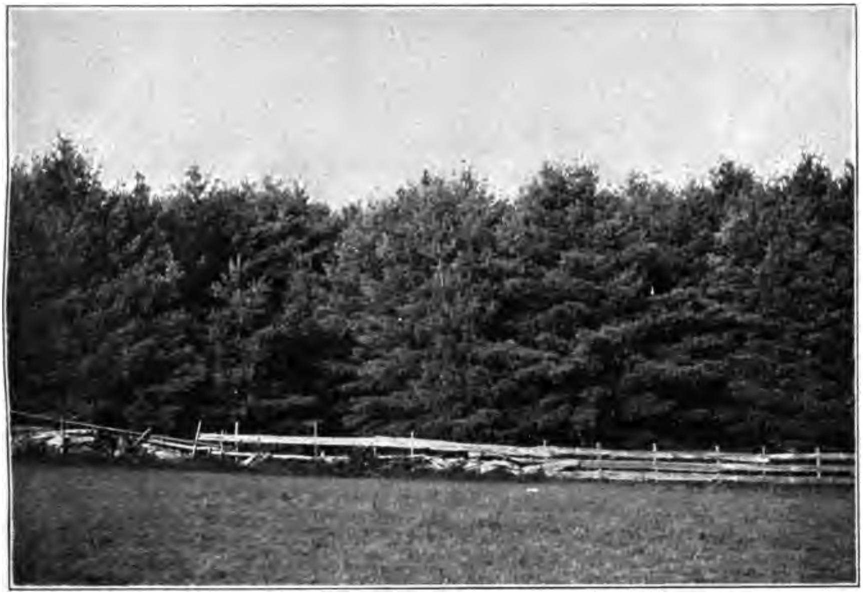

FIG. 1.—YOUNG STAND OF WHITE PINE ON FORMER PASTURE LAND.

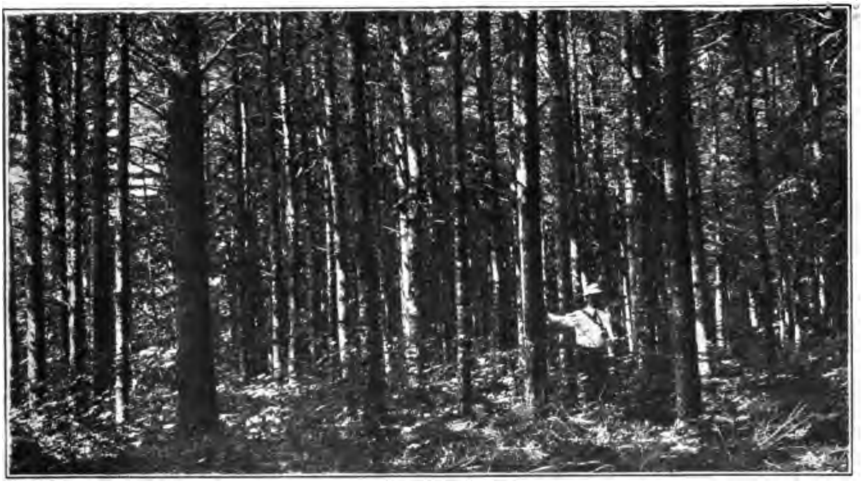

FIG. 2.—AN EVEN-AGED STAND OF SECOND-GROWTH WHITE PINE, 50 YEARS OLD.

The tables show the characteristic wide range in diameter of even-aged white pine stands. This great variation, including the numerous suppressed as well as the intermediate and dominant trees in each stand, explains the seeming discrepancy between the age of the stands shown in Tables V, VI, VII, and VIII, and the rate of diameter growth given in Table III. The latter represents the development of the trees which hold leading positions throughout the life of a stand, and does not represent the rate of growth obtained by averaging the many suppressed trees with the few largest ones, the latter being advance growth a little older than the rest. The stand represented by Table V, for example, averages a diameter which Table III would give for trees 14 or 15 years old; but, as a matter of fact, nearly all the smallest trees in Table V will die, while those over 8 inches are older, advance growth, so that the trees ranging from 4 to 8 inches, inclusive, are the significant ones, and these correspond more closely with the growth rate for dominant trees in Table III.

TABLE V.—*Composition of second-growth white pine stands 21 to 30 years old.*

[Average of 1.3 acres.]

Diameter breasthigh.	Number of trees per acre.						
	White pine.	Dead white pine.	Gray birch.	Red maple.	Aspen.	Pin cherry.	All species.
Inches.							
2	497.7	1.9	56.2	30.8	4.6	2.3	593.5
3	405.3	.8	48.4	10.8	2.3		467.6
4	216.2		34.6	3.8	3.8	1.5	259.9
5	121.6		3.1	3.8	2.3	.8	131.6
6	42.3			.9	.8		44.0
7	16.2				1.5		17.7
8	2.3						2.3
9	1.5						1.5
10							
11	.8						.8
Total	1,303.9	2.7	142.3	50.1	15.3	4.6	1,518.9
Per cent	85.8	.2	9.4	3.3	1.0	.3	100.0

TABLE VI.—*Composition of second-growth white pine stands 31 to 40 years old.*

[Average of 6.2 acres.]

Diameter breast-high.	Number of trees per acre.										
	White pine.	Dead white pine.	Red maple.	Gray birch.	Spruce.	Red oak.	Aspen.	Red pine.	Balsam fir.	Pin cherry.	All species.
Inches.											
2	124.0	75.8	7.9	10.9	1.8	0.5	1.3	0.5	0.8	0.5	224.0
3	166.1	20.0	6.3	4.5	1.5	1.1	1.1	.6	.3	.5	202.0
4	180.6	3.4	2.3	.9		1.1	.8	.5	.8	.5	190.9
5	155.3	1.3	2.7	.8		1.1	.8	.3	.2	.6	163.1
6	115.0	.8	.8	.3	.9	.2	.2	.6		.2	119.0
7	84.0	.2	.8	1.1	.2	.2		.3	.2		87.5
8	45.0		.2	.2	.2	.3					45.9
9	22.7		.5								23.2
10	10.0		.2								10.2
11	3.2		.2								3.4
12	4.7										4.7
13	1.6										1.6
14	.6										.6
Total	912.8	101.5	21.9	18.7	4.6	4.5	4.2	2.8	2.3	2.3	1,076.1
Per cent.	84.9	9.5	2.0	1.7	.4	.4	.4	.3	.2	.2	100.0

TABLE VII.—*Composition of second-growth white pine stands 41 to 50 years old.*

[Average of 15.9 acres.]

Diameter breasthigh.	Number of trees per acre.								
	White pine.	Dead white pine.	Red maple.	Gray birch.	Hemlock.	Aspen.	Red pine.	Red oak.	All species.
Inches.									
2	6.9	32.8	6.5	0.9	2.4	0.7		0.1	50.3
3	26.7	35.2	3.0	.5	1.8	.3	0.1	.1	67.7
4	48.4	27.0	3.4	.8	.7	.4	.1	.1	80.9
5	63.8	14.2	1.9	.9	.2		.1	.1	81.2
6	54.4	5.5	1.0	.2	.3	.4		.1	61.9
7	76.4	1.5	1.2	.4	.1	.1	.1		79.8
8	70.9	.2	1.0	.5	.1	.1	.3	.1	73.2
9	55.4	.1	.2	.3	.3		.3	.1	56.7
10	39.2		.3	.1	.4		.2		40.2
11	26.7			.1					26.8
12	15.2			.1					15.3
13	7.3								7.3
14	3.2			.1					3.3
15	2.3								2.3
16	1.0								1.0
17	.5								.5
18	.3								.3
19	.3								.3
Total	498.9	116.5	18.5	4.9	6.3	2.0	1.2	.7	649.0
Per cent	76.8	18.0	2.8	.8	1.0	.3	.2	.1	100.0

TABLE VIII.—*Composition of second-growth white pine stands 51 to 60 years old.*

[Average of 11.9 acres.]

Diameter breasthigh.	Number of trees per acre.						
	White pine.	Dead white pine.	Hemlock.	Red maple.	Gray birch.	Red oak.	All species.
Inches.							
2	0.6	2.2	4.8	2.1	0.3	0.1	10.1
3	2.0	3.7	3.5	.9	.3	.2	10.6
4	3.0	6.6	1.6	1.0	.4	.2	12.8
5	8.4	6.3	2.0	.3	.2	.2	17.4
6	14.2	6.1	.9	.4	.2	.3	22.1
7	21.2	2.1	.3	.2	.1	.2	24.1
8	24.7	.9	.3	.1	.1		26.1
9	27.5	.3	.2	.1			28.1
10	38.0	.2	.1	.1			38.4
11	33.3	.1	.5				33.9
12	31.3	.1					31.4
13	26.1						26.1
14	22.9						22.9
15	18.3						18.3
16	9.8						9.8
17	6.8						6.8
18	5.5						5.5
19	3.5						3.5
20	1.3						1.3
Total	298.4	28.6	14.2	5.2	1.6	1.2	349.2
Per cent	85.4	8.2	4.1	1.5	.5	.3	100.0

The character and development of the pure stand depend upon the situation and upon the conditions of replacement under which it began life. Pine trees on a fresh, well-drained soil of good quality are taller and larger in diameter than those of the same age situated on poor, loose, dry soil. A pine stand on a fertile, loamy soil in a swale may be one-third taller than one of the same age on a sandy plain. This difference may be noted anywhere, but the average size of the trees in one region does not differ essentially from that of trees of the same age grown under like conditions in another region.

Within the white pine district the development of the tree is similar on similar situations.

Pure white pine woods may be classed as even or uneven aged. The extension of white pine over a field or pasture in the way described requires a length of time embracing one or more seed years. The best stands are those that were established by one seed year, as a longer period of replacement results in a less regular stand. Even-aged stands must have sprung from not more than two seed periods. The individual trees in such a stand differ in age according to the number of years it took to seed the land, but if this difference exceeds the length of time between seed years—five to seven years—the stand takes on the uneven-aged character.

The present merchantable stands of pine in New England are nearly all of the even-aged character. (Pl. IV, fig. 2.) In the seedling stage of even-aged stands there is usually no marked crowding for space, but between the ages of 10 and 20 years the branches of the saplings close together and the struggle for growing space and light begins. The trees do not differ greatly in height, and the struggle becomes a very sharp one. Some trees get a little ahead and, having more light, develop faster; many lag behind and die. The three classes of dominant, intermediate, and suppressed trees are soon formed.

The closing together of the crowns completely shades the ground, and hence the moisture conditions become better and more favorable to a good growth, while the lower branches are shaded and begin to die. A double stimulus is thus given to the growth of the upper part of the crown, and between the ages of 20 and 40 years the rate of height growth is very rapid. By this natural process the trees obtain long stems and the merchantable value of the stand is assured.

From the beginning of this struggle the number of trees to the acre has diminished. As the stand grows older fewer trees die and the contention for growing space is less sharp. The trees that die contribute to the value of the stand by their death, which improves the conditions for those remaining and enables them to develop a greater size. Table IX shows how this natural thinning progresses.

TABLE IX.—*Average number of white pine trees per acre in second-growth stands of different ages.*

Age.	Average height.	Number of trees per acre.	Number of trees dying per decade.
Years.	*Feet.*		
10	5	2,220	
20	14	1,600	620
30	32	1,090	510
40	54	690	400
50	68	400	290
60	76	260	140

Uneven-aged stands are usually due to the lack of adjacent seed trees, and, in some situations, to an unfavorable condition of the ground cover as well. The appearance of the stand is irregular, and many of the trees which had the earliest start are branchy and short stemmed, since they were not crowded by others of the same size. Such stands are of much less value commercially than even-aged stands, and they illustrate well the kind of woods which will grow from many seedling stands that are incompletely stocked and uneven in development.

THE CARE OF A YOUNG FOREST.

A sapling stand will grow into a merchantable pine lot without any other care than protection from fire, but certain operations for the improvement of the growth should be undertaken by the owner who is willing to incur a slight expense for the sake of greater final results.

PRUNING.

The pruning of the lower green branches of sapling trees is sometimes practiced. This is not advised in any naturally established stand of white pine. It is asserted by some manufacturers in New England that pruning causes numerous loose knots, which fall out when the boards are sawed, resulting in lumber unfit for boxes. Purchasers of pine have refused to buy lots that were known to have been pruned. The loose knot is more probably the result of careless pruning, by which a stub was left that required years for the tree to overgrow.

From another and more practical standpoint the pruning of second-growth saplings is inadvisable, because it involves an expense which is not justified by the results. Pails, match blocks, and boxes comprise the important uses of second-growth pine. Pail manufacturers saw out the clear sections of the tree between the whorls of branches, thus avoiding the knots, and it is a positive disadvantage to them if the growing branches or the characteristic branch scars are not present to serve as guides.

In making match blocks the knotty portion is sawed out of the plank and used for firewood. For box manufacturing the boards are graded, and even the most knotty ones have some use provided the knots are firm. Pruning, therefore, is unnecessary.

In case it is the intention to reserve a stand for final disposal as saw timber when it is between 80 and 100 years of age, clearer wood might be secured by trimming off all the lower branches shortly after they die. It is doubtful if this ever pays; yet it may be undertaken if injury to the bark is avoided. The branch should always be cut off as close as possible to the stem of the tree.

THINNING.

In some stands, or parts of them, the first step in their care will be called for when the trees are no more than from 10 to 15 years old. The saplings are then about as high as one's head. If the individual trees are so close together at their bases that one can not force a passage through them—that is, 1 foot or less apart—the stand can be improved by the removal of some. This condition is likely to exist within 30 feet of the parent seed woods. The operation is a simple one. Cut clear lanes 3 feet wide through the stand, and let these lanes be 6 feet apart. After this is done the remaining stand will consist of 6-foot strips of saplings, separated by cleared spaces 3 feet wide. The saplings on the edges of the clear lanes will soon respond to the stimulus of light and greater growing space, and a proper number of trees will get a lead over the others within the strips. This step must never be taken except where extreme density interferes with a normal development.

The majority of pure pine stands need no treatment until they are about 30 years old and are entering the pole stage. A thinning, different from that just described, is then desirable in the following cases:

(1) If the stand is too dense for thrifty development.

(2) If a market can be found for the product.

(3) If the owner is willing to undergo some expense in order to improve the stand and hasten its maturity.

In the struggle for existence the natural process of thinning may consume a long time when the number of trees is too great and they are all being dwarfed. Such a condition is apparent if the trees are all tall and very slender, closely crowded together, and have very small crowns. The removal of some of the trees gives the rest space in which to enlarge their crowns and to grow faster. Thinning is then undertaken to give the best trees more room. The point which must be kept in mind in choosing the trees to be cut is the extent to which the crown canopy is broken. The thinning must make no large open spaces in the canopy, for if the stand is opened up too much it means a serious checking of the height growth and a smaller final value of the lot. The work should be supervised carefully and the trees to be taken out should be marked. Diagrams illustrating the principal methods of thinnings are published in another bulletin.[a] A careful study of this publication will enable the pine lot owner to carry out the necessary thinnings.

The last step in the care of a pure pine stand is so to lumber it that seed trees shall be left to insure a prompt and perfect restocking of the area.

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[a] The Woodlot, Graves and Fisher. Bulletin No. 42, Bureau of Forestry.

In case the stand has developed to the small sapling stage beneath an advance growth of gray birch and other species less valuable than white pine, there is an opportunity for a timely operation in thinning. The pines may be greatly assisted in their struggle for a permanent place in the stand by cutting out individual birches that are dwarfing them. In not a few instances the branches of the birch, whipped by the wind, strip the needles and buds from the leading shoots of neighboring pines, thus permanently injuring them. It is a matter of slight expense for a farmer to remove a birch here and there. The wood may be used for fuel, or, if it is too small for firewood, it can be laid close to the ground, where it will soon decay.

In thinning older stands composed of mixed pine and hardwoods, the inferior species should, whenever practicable, be removed at the same time as those which directly interfere with the development of the pine, unless they are needed to maintain the soil cover or to help clear the stems of the pines. No general rules can be given here for this operation, since each situation requires special treatment.

LUMBERING.

PRESENT METHODS.

There is little waste involved in the lumbering of second-growth white pine as now practiced. The trees are felled by sawing, the stumps are cut low, and the logs are run as far into the tops as possible. In some localities the limbs and tops are cut into cordwood.

Two methods are in common use. By one method a portable sawmill is set up at a convenient point on the lot to be cut, and the logs are sawed at once into boards and planks. The lumber is piled in an adjacent field or pasture to season for about a year before it is taken to the place of consumption.

The other method is to cut the trees and haul the logs directly to the place where they are to be used, or to haul them to a stream or a railroad line by which they can reach the mill.

In most localities the portable mill is used, and all the merchantable pines on the lot are cut. Only a few suppressed trees, under 4 inches in diameter breasthigh, are left.

In southwestern Maine, in the region of Sebago Lake, it has been customary for the owners of woodlots to cut their own pine and haul it to the mill. This has furnished winter work for the farmers. The portable mill is gradually beginning to supersede this method. In many cases only a part of the timber was removed; the rest was allowed to remain and grow. This removal of part of the stand frequently has the effect of a heavy thinning, and the trees that are left grow faster because they have more space and light. Where the remaining trees are tall and slender, however, they may be subsequently felled by the wind if the stand is in an exposed situation. The branches and